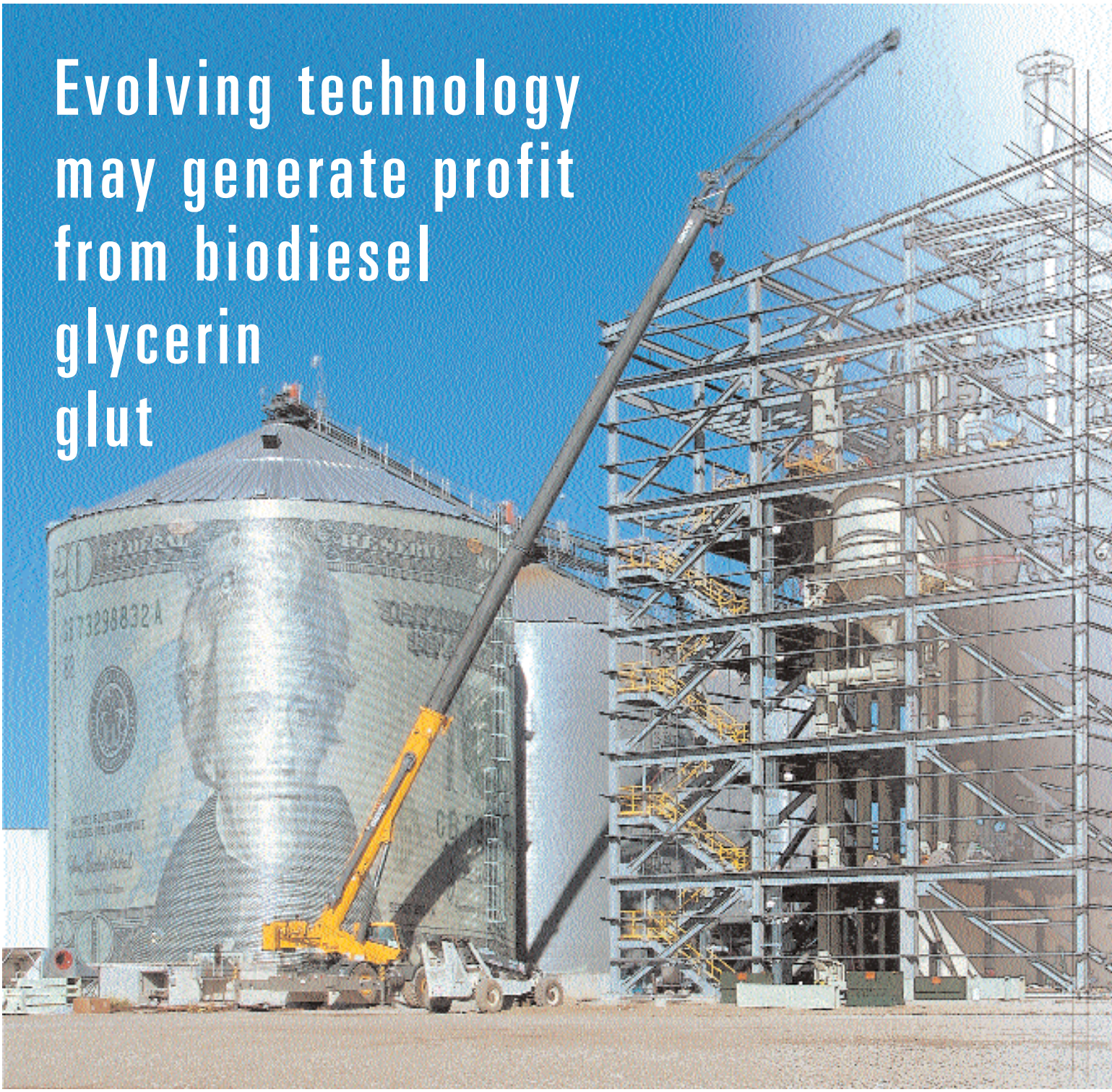
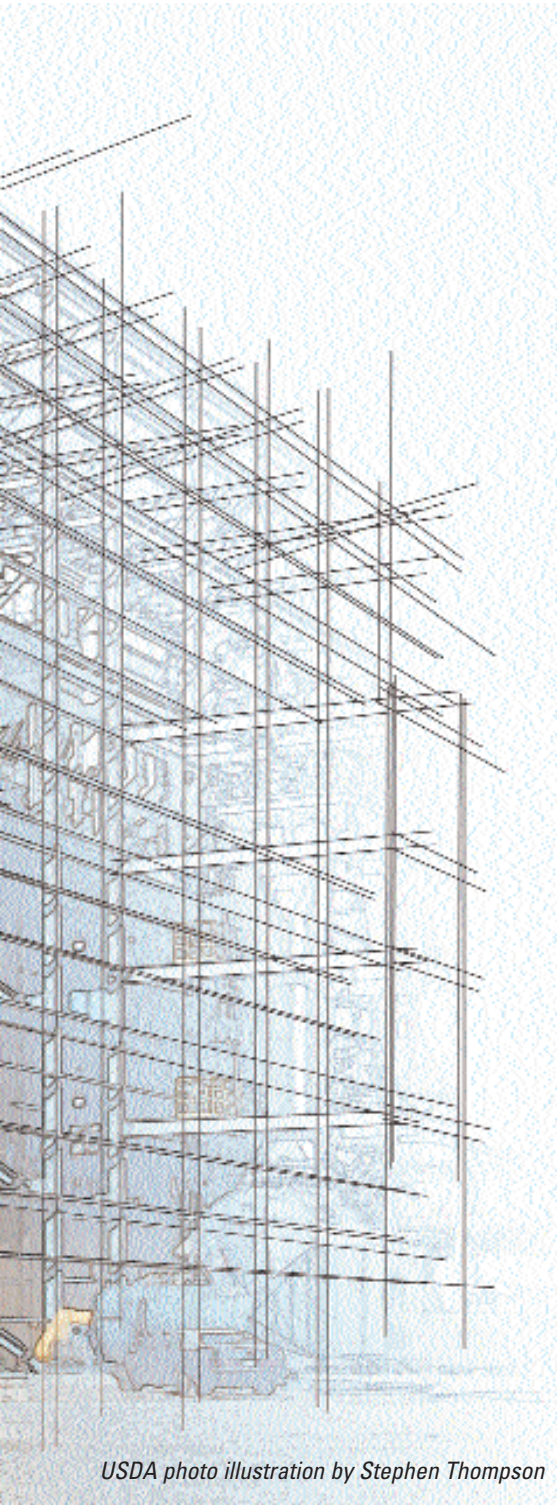
Evolving technology may generate profit from biodiesel glycerin glut



By Anthony Crooks, Ag Economist
USDA Rural Development

Glycerin (glycerin, glycerol) is the main co-product resulting from biodiesel production. The name comes from the Greek word glykys, meaning sweet. It is a colorless, odorless, viscous and nontoxic liquid with a sweet taste and literally thousands of uses – at least for pure glycerin. The biodiesel glycerin co-product is in crude form. Once separated from the soaps, lye and other byproducts, however, this glycerin has significant market value.

Every gallon of biodiesel produced generates 1.05 pounds of glycerin. So a 30-million-gallon-per-year plant will generate about 12,700 tons annually of 99.9 percent pure glycerin. Along with the 600 million gallons of biodiesel soon to be added to the nation's production capacity will come about 315,000 tons of glycerin. With an expected U.S. production of 1.4 billion pounds of glycerin between 2006 and 2015, North American glycerin markets



USDA photo illustration by Stephen Thompson

will be significantly affected by industry growth.

A glutted glycerin market is more than a concern for the farmer-owned co-ops and limited liability corporations (LLC) and other producers of biodiesel. The European glycerin supply is already in over supply. When combined with fatty acid production from palm kernel oil and coconut oil in Southeast Asia, all are adding to the world's glycerin surplus. Biodiesel production is now the most important determinate in the supply of glycerin.

The nation's synthetic glycerin market has also felt the effects. Dow Chemical, once the only synthetic producer of glycerin in the United States, recently closed its Freeport, Texas, plant, saying that the flood of glycerin from U.S. biodiesel plants was at least partially responsible.

Like biodiesel itself, glycerin quality is a concern for refiners. Crude glycerin quality may be as varied as the process technology used to produce biodiesel. Typically, the large, professionally engineered plants have a more consistent glycerin because more attention is paid to refining the co-product. Smaller, self-designed facilities are more often just trying to get biodiesel produced and pay less attention to glycerin quality.

Useful molecule

While some community-based biodiesel producers tout soap-making or aerobic composting as potential solutions, that's hardly sufficient for commercial-scale operations. The most likely use for glycerin will be to replace petroleum-based chemicals. Within five years, glycerin is expected to become a developmental platform from which an array of chemical applications will spring as a replacement of a petrochemical equivalent.

An often discussed idea is to convert glycerin to antifreeze. Researchers at the University of Missouri and the Columbia, Mo.-based Renewable Alternatives LLC have completed the first phase of a project using hydrogenation to convert glycerin to propylene glycol. The process turns glycerin and hydrogen into equal parts propylene glycol and water. Plans are underway to scale-up the process for commercialization.

Researchers at Washington State University's Biological Systems Engineering Department are studying how to develop omega-3 fatty acids, succinic acid and succinate salts from glycerol. The U.S. Department of Energy recently identified succinic acid as one of the top 12 biorefinery chemicals to be derived from biomass.

The USDA Agricultural Research Service's Environmental Quality Laboratory in Beltsville, Md., discovered that glycerin from biodiesel production and citric acid can be chemically combined to produce biodegradable polymers, which could be used to produce packaging and other products. An important feature of the process is the use of unrefined glycerol specifically from biodiesel production.

Citric acid is reacted with various alcohols, or hydroxyl-containing materials such as glycerol, to obtain a polyester polymer that is biodegradable, edible, biocompatible and useful in the making of films, sheets, plastics and gel-like coatings. Because it is biodegradable, the material holds significant promise for use in packaging materials.

Soy Oil-glycerin products explored

The Ohio Soybean Council and the Battelle Memorial Institute are working together to pioneer new uses for soybean oil and glycerin in the development of polyols, which are used to make polyurethane foams, polyester, adhesives and other goods. Glycerin and soybean oil can be chemically modified (using ozone treatment and/or selective oxidation) to make soya-polyols that are competitive with the petroleum-based products.

The U.S. polyol market is nearly 1 billion pounds and represents a significant value-added opportunity for the biodiesel co-ops and other producers to pursue. Because of what is called "low reactivity," however, soy-based polyols need to be blended with petroleum counterparts, just as biodiesel is blended with petroleum diesel, to make specialty products.

Battelle's business strategy is to license technology to interested companies. Ideally, the new technology will alter a biodiesel plant into a multi-faceted biorefinery with multiple product streams, just as with a

petroleum refinery. A 100-million-gallon biodiesel refinery generates from 60 to 75 million pounds of glycerin, or about 200 million pounds of polyols per year. At the current price of about $1 per pound, polyols can add another $200 million in revenue to a biodiesel plant's bottom line.

Battelle's vision is for these refineries to produce biodiesel for transportation fuel, and to invest in the process to manufacture polyols for the plastics and polymers industries as a springboard to multiple processes, products and revenue streams. Ultimately, every product stream from the plant will become a value-added revenue source.

Researchers at Battelle in Columbus, Ohio, are working to find new uses for soybean byproducts. Such work is funded in part by Soybean Checkoff dollars, contributed by producers. Photo courtesy Ohio Soybean Council

Battelle isn't alone in the development of polyols. Cargill Inc. recently announced that it had won a technology award from the Alliance for the Polyurethanes Industry for its BiOH bio-based brand of polyols. ADM plans to produce propylene glycol and other "large-volume" chemicals from glycerin. Many people are aware that propylene glycol is used for antifreeze/deicer, but it is also used for fiberglass resins, personal care products and cosmetics.

Alternative energy source

The "floor value" of any material, including glycerin, can be determined by the point at which it can be used as an energy source. For example, distillers grains produced as a byproduct of the ethanol industry can be used as a supplemental energy source. Of course, burning distillers grains and glycerin is a last resort and is best avoided, because glycerin typically doesn't burn well, and crude glycerin gives off toxic fumes when burned, limiting its energy potential.

However, Virent Energy Systems and the University of Wisconsin-Madison Department of Chemical and Biological Engineering believe that glycerol can be an energy source through aqueous phase reforming (APR). APR generates hydrogen from aqueous solutions of oxygenated compounds in a single-step reactor process.

Low-grade crude glycerin is especially favored because it is cheaper and readily converts to hydrogen. Its sodium hydroxide, methanol and the high pH levels actually help the process. About 10 pounds of glycerin can be converted to 1.5 pounds of hydrogen in Virent's process for less than $2 per kilogram.

Electricity

Researchers at eTEC Business Development Ltd., a biofuels research company based in Vienna, Austria, have devised mobile facilities that successfully convert the biodiesel by-product glycerin into electricity. The facilities, according to researchers, will provide substantial economic growth for biodiesel plants while turning glycerin into productive renewable energy.

The glycerin is burned in specially adapted engines to produce electricity. Stable and virtually maintenance-free, eTEC's units consist of a glycerin processing module, a combustion engine with a generator and a control unit that is compatible with any biodiesel plant. With the unit's low malfunction rate and compact design, it can be integrated into a transfer encasement, making it easy to be transported, assembled and moved from one biodiesel plant to another, if desired.

Because electricity is expensive in Europe, biodiesel producers will be able to create their own electrical energy using eTEC's technology to help offset feedstock cost. In addition, heat is simultaneously released during the electricity conversion process, which can be used for heating the plant's tank facilities. eTEC also has plans to reconvert heat back into electricity. Unused electricity can also be fed into the main supply grid for use at the European sponsored eco-electricity rates. Having this kind of 'green' electricity is supported by the local states in the EU, so it is quite profitable for biodiesel projects.

Biogas, methane digester

A Belgian biogas firm, Organic Waste Systems (OWS), is building a methane digester system that uses crude glycerin and resulting biogas from a commercial-scale biodiesel facility to power the plant itself. Such an integrated, closed-loop system has many benefits and makes the biodiesel production process "greener." Glycerin is reported to increase biogas yields considerably, provided the right microbial populations are used.

The Agricultural Utilization Research Institute (AURI) in Marshall,

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Marion and has additional facilities in Freeman and Dimock. Its services include agronomy, grain and feed.

Fremar has developed one of the largest producer-owned ethanol projects in South Dakota. Construction on Millennium Ethanol, a 100-million-gallon ethanol plant, is expected to be completed by the end of 2007. US BioEnergy has announced a plan to acquire the plant. ■

Top Co-op Communicators

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success in raising the communications program at her co-op to a new level since joining it in 2001. She serves as editor of her co-op's magazine and newsletter, is responsible for special event planning, advertising, media relations, Web site maintenance, photography and a variety of other marketing and communication projects.

Ditsch, who just assumed the CCA presidency, was called "one of the nation's most creative, talented and detailed communicators." She "consistently demonstrates the seven principles of cooperatives in all that she does. Because her work always displays a high level of professionalism, many other purchasing co-ops borrow her talent and follow her lead."

H.E. Klinefelter, who died in 1957, was one of CCA's founders and an employee of what today is MFA Inc. Michael Graznak was a talented communicator with Farmland Industries. He died at age 51 of a heart attack while on an assignment for the co-op.

Other top awards

CCA awarded its other top honors to:

- Photographer of the Year — David Lundquist of CHS Inc./Land O'Lakes;
- Publication of the Year — Sara Dorman of West Central Cooperative;
- Special Projects/Programs, Best of Class — Morriah Morris of the Wisconsin Milk Marketing Board;
- Writer of the Year— Dan Campbell, editor of USDA's *Rural Cooperatives* magazine.

Other awards won by *Rural Cooperatives* staff or contributors included: Anne Todd, first place featurette for an article about a co-op for housecleaners; Catherine Merlo, first place serious/investigative feature for "Left Behind," about grain co-ops that have lost business due to biofuels development; Dan Campbell, second place for serious/investigative features for "The Natural," about a natural beef cooperative, and third place in the cooperative education category for an article on the 80th anniversary of the Cooperative Marketing Act; Assistant Editor Stephen Thompson, third place in the news category for coverage of a renewable energy conference. The magazine was awarded third place for best overall use of photos in a publication. ■

Biodiesel Glycerin Glut

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Minn., has studied the possibility of using glycerin as a fuel or fuel supplement. One study tested glycerin in wood pellets fueling a wood-burning stove. But analysis show no real significant improvement with the glycerin mixture.

Animal feed

AURI also works with Minnesota biodiesel producer FUMPA Biofuels to combine feather meal and glycerin for use in beef and dairy diets. Because glycerin produced at the plant is about 85 percent pure, pH neutral and free of soaps and methanol, FUMPA has a unique product opportunity and is able to capitalize on the synergy between its biodiesel and animal feed divisions.

FUMPA has developed an animal feed consisting of a blend of Central Bi Products' hydrolyzed feather meal with glycerin. Gro Mor Hi-Torque, as the product is branded, was developed in part through the Agricultural Utilization Research Institute's (AURI) co-product utilization lab in Waseca, Minn., where AURI developed a method for making pellets from the mixture.

Various blends of glycerin and feather meal were tested to develop a high-density feed with pellet durability greater than 95 percent, making it ideal for high-volume transportation and extending the product's shelf life.

Poultry feed

A more recent animal feed trial using glycerin has received national attention. Researchers at the University of Arkansas' Center of Excellence for Poultry Science recently studied glycerin as a dietary supplement in growing broiler chickens. Although strictly preliminary, the study showed that as much as 10 percent glycerin could be fed to chicks up to 16 days of age in battery brooders. Battery brooders are brooding boxes with wire floors stacked on top of each other to conserve space.

A 5-percent glycerin inclusion in pelleted feed showed no adverse effect on bodyweight, feed intake, feed conversion or mortality. However, 10-percent glycerin inclusion reduced body weight due to reduced feed-flow rate.

A second study will determine the effects of a 2- to 2.5-percent glycerin inclusion to more accurately represent real-world market conditions. The typical poultry operation mixes 4,000 tons of feed per week and would require a commercial-scale biodiesel plant to have enough glycerin for even a 1-percent inclusion. ■